United States Patent [19]

Rapino et al.

[11] **4,057,907**

[45] **Nov. 15, 1977**

[54] **METHOD AND APPARATUS FOR DRYING CLOTHES**

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[21] Appl. No.: **708,650**

[22] Filed: **July 26, 1976** (Under 37 CFR 1.47)

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 489,475, July 18, 1974, Pat. No. 3,972,126.

[51] **Int. Cl.**[2] **F26B 3/30;** F26B 7/00; F26B 19/00

[52] **U.S. Cl.** **34/4;** 34/12; 34/15; 34/17; 34/60; 34/92; 34/133

[58] **Field of Search** ..... 34/3, 4, 12, 15, 17, 34/92, 133, 60, DIG. 14

[56] **References Cited**

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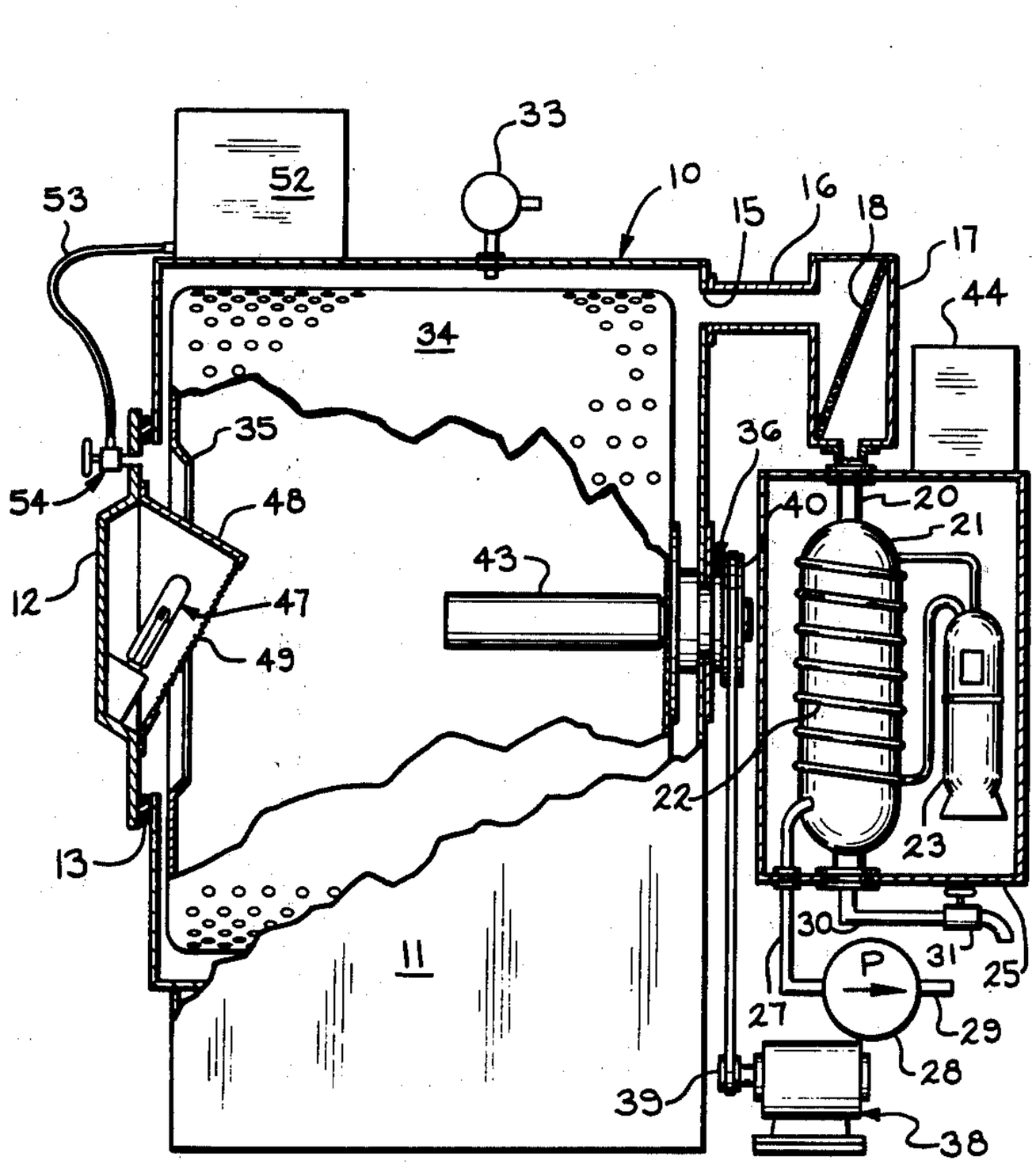
[57] **ABSTRACT**

A dryer for the rapid drying of clothing and other articles is disclosed. The dryer includes a chamber which receives the clothes or other articles. A vacuum pump reduces the air pressure within the chamber to below atmospheric. A microwave emitter directs radiant energy into the wet clothing to excite the water molecules while an ultrasonic generator is adjacent the chamber for breaking large water aggregates into smaller units.

3 Claims, 1 Drawing Figure



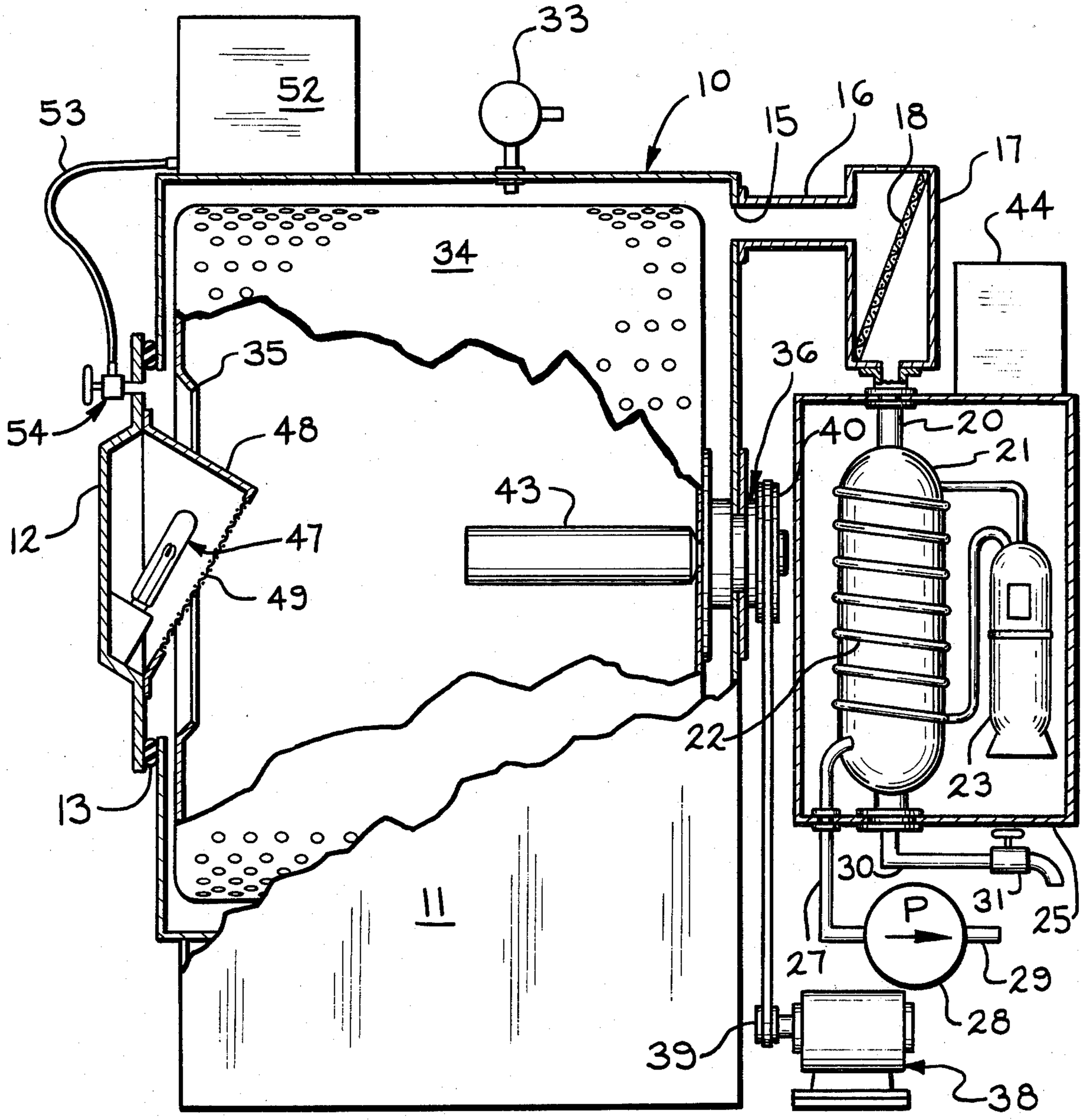

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FIG. 1

METHOD AND APPARATUS FOR DRYING CLOTHES

CROSS-REFERENCE TO RELATED PATENT APPLICATION

This application is a continuation-in-part of application Ser. No. 489,475, filed July 18, 1974, now U.S, Pat. No. 3,972,126.

BACKGROUND OF THE INVENTION

Various methods and apparatus have been used in the past for drying clothes and other articles found in either household or commercial laundry operations. Such other articles are, for examples, towels, sheets, laboratory coats and the like.

Many prior art apparatus, used in the drying of clothes, merely involve the heating of the clothes by various means together with the tumbling of the clothes in, for example, a rotary drum apparatus. Some prior art methods of heating involve the use of electrical resistance heating and gas burner heating, both of which were normally used when the clothes were in an ambient pressure situation.

However, other prior art drying methods included applying a vacuum to the articles being dried or the introduction of radio frequency current flow into the articles. Such a prior art method is disclosed, for example, for use in the drying of rayon thread cakes, in U.S. Pat. No. 2,325,652.

The major problem in connection with prior art methods and apparatus is the time needed to dry the damp articles.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary, diagrammatic view, partially in cross section, to show internal parts of one embodiment of a clothes dryer constructed according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A clothes dryer, constructed according to the present invention, is generally indicated in FIG. 1 by the reference number **10**. The clothes dryer **10** is used for the rapid drying of clothes and other articles, for examples, towels, sheets, laboratory coats and similar articles. While the present embodiment is more adaptable to commercial laundry operations, including hotels, hospitals, universities and the like, other embodiments are adaptable for household use.

However, in a household unit, or other applications where metal zippers or other metal items are present within the articles to be dryed, an additional heater coil-fan circuit is provided (not shown) together with switching apparatus for deactivating the normally used micro-wave source.

The clothes dryer **10** includes a cabinet **11** having an entrance door **12**. A perimeter seal **13** surrounds the door **12**. The cabinet **11** defines an opening **15** which is in communication with a vacuum duct **16**. The vacuum duct **16** extends between the cabinet **11** and a lint chamber **17**. The lint chamber **17** includes a filter **18** and a pressure sealable port (not shown) for the removal and replacement of the filter **18**. A conduit **20** extends between the lint chamber **17** and a cooling chamber **21**. Coils **22** surround the cooling chamber **21** and are in communication with a compressor assembly **23**. The cooling chamber **21** and the compressor assembly **23** are located within a dehumidification enclosure **25**.

Other types of dehumidification apparatus may be utilized, either as an alternative to the cooling chamber **21** and the compressor assembly **23** or as a supplement. For example, desiccants including silica gel are suitable in some installations and may be placed directly within the cabinet **11** to speed the drying processes.

A conduit **27** extends from the lower portion of the cooling chamber **21** and is in communication with a vacuum pump **28**. A conduit **29** extends from the vacuum pump **28** to atmosphere in this embodiment. A drain line **30** including a valve **31** extends from the lowermost portion of the cooling chamber **21** to drain condensed liquid from the cooling chamber **21**.

A pressure valve **33** is mounted through the upper wall of the cabinet **11**. The pressure valve **33** operates both as a safety valve and as an air supply valve. When the pressure within the sealed cabinet **11** reaches a predetermined level, the pressure valve **33** opens allowing atmospheric air to enter the cabinet **11**.

In the present embodiment, a perforated drum **34** having a side opening **35** is rotably mounted by a bearing assembly **36** to the cabinet **11**. A motor and gear reducer assembly **38** includes an output pulley **39** which is in alignment with a pulley **40** of the bearing assembly **36**. A belt **41** extends between the pulleys **39** and **40** to rotate the drum **34**.

In the present embodiment, an ultrasonic probe **43** is mounted by the bearing assembly **36** and extends inwardly within and along the axis of rotation of the drum **34**. If desired, an ultrasonic generator **44** mounted on the dehumidification enclosure **25** may also be utilized. The probe **43** and the generator **44** breaks the large water aggregates or agglomerates into smaller units as the wet articles tumble within the drum **34**.

A microwave unit **47**, is mounted within the entrance door **12** of the cabinet **11** and directs microwaves into the drum **34**. This energy excites the water molecules to aid the evaporation or drying process. The microwave unit **47** is mounted below a shield **48** and a protective screen **49** is positioned in front of the unit **47**. The microwave unit **47** has an electrical disconnect to insure that the unit **47** is inoperable when the entrance door **12** is open. In addition, the entire clothes dryer **10** is shielded to prevent undesired radiation exterior of the cabinet **11**.

In the present embodiment, a liquid container **52** is mounted on the top of the cabinet **11**. A flexible hose **53** extends from the liquid container **52** to a valve fitting **54** mounted in the entrance door **12** of the cabinet **11**. In the present embodiment, cosolvents such as low molecular weight alcohols or ethers are placed in the liquid container **52**. The cosolvents are introduced into the cabinet **11** by opening the valve fitting **54**. The cosolvent moves downwardly over the shield **48** directly into the drum **34**.

During a typical operation of the clothes dryer **10**, the entrance door **12** is opened and wet articles are placed within the drum **34**. The door **12** is closed and the motor assembly **38** is actuated, together with the vacuum pump **28**. The pressure within the cabinet **11** is reduced to a sub-atmospheric level. The drum **34** begins to rotate and the damp articles tumble. The ultrasonic probe **43** and ultrasonic generator **44** are actuated together with the microwave unit **47**. As the damp articles tumble, the ultrasonic probe **43** breaks down large

water aggregates into smaller units thus causing evaporation to proceed at a more rapid rate.

The microwave emitter, in this embodiment the unit **47**, directs microwave radiation toward the wet articles. Preferably, the drum **34** is constructed of a plastic material which is transparent to microwave radiation. The microwave radiation excites the water molecules and greatly speeds evaporation. While infrared radiation may be used, it has been found that microwave radiation does a much faster, more efficient job of aiding in the evaporation of water.

The vacuum pump **28** maintains a sub-atmospheric pressure within the cabinet **11**. It has been found that the combination of sub-atmospheric pressure, ultrasonic emissions and microwave radiation greatly reduces the time necessary to dry wet or damp articles.

The vacuum pump **28** pulls air through the cooling chamber **21**, the lint chamber **17** and the vacuum ducting. The cooling chamber **21** removes moisture from the clothes dryer air. It has been found that such dehumidification retards the contamination of the vacuum pump **28**.

The system air is also passed through the filter **18** of the lint chamber **17** prior to its passage through the cooling chamber **21**. As mentioned above, a cosolvent such as a low molecular weight alcohol or ether may be introduced into the drum **34** to aid in the evaporation of water by reducing the effective concentration of water, replacing it instead with a more volatile substance. Since the use of a cosolvent introduces a more explosive mix into the clothes dryer **10** and also of necessity requires the removal of such substances from the effluent, the use of cosolvents is more adaptable to a large scale commercial operation as opposed to, for example, home use or a smaller commercial application.

The makeup air is introduced through the pressure valve **33** which, in addition, protects the clothes dryer **10** in the event that the pressure within the cabinet **11** falls below a predetermined level. The pressure valve **33** also includes a manual or automatic release to vent the system to atmosphere, for example, after the articles are dried.

It has been found that the method and apparatus for drying articles, according to the present invention, greatly reduces the time of drying as compared to a typical prior art dryer.

What we claim is:

1. A method of drying clothes comprising the steps of placing the clothes in a sub-atmospheric space, maintaining the sub-atmospheric pressure within the space, agitating the clothes, ultrasonically vibrating the clothes to break large water agglomerates into smaller units and applying microwave radiation to the clothes to excite the water molecules and speed evaporation.

2. A clothes dryer comprising, in combination, chamber means for receiving clothes to be dried, pressure reducing means in communication with said chamber means for reducing the pressure within said chamber means to below atmospheric and for maintaining the below atmospheric pressure within the space, an ultrasonic generator means adjacent said chamber means for breaking large water aggregates into smaller units and microwave means adjacent said chamber means for exciting the water molecules thereby speeding evaporation.

3. A clothes dryer comprising, in combination, a cabinet having an entrance door, said cabinet being airtight wherein a sub-atmospheric pressure may be maintained, a drum mounted for rotation within said cabinet, said drum defining an opening in communication with said entrance door whereby wet articles can be placed within said drum, motor means for rotating said drum, a vacuum pump in communication with said cabinet for reducing the pressure within said cabinet to sub-atmospheric, ultrasonic generator means adjacent said cabinet and said drum for breaking large water agglomerates into smaller units and microwave means adjacent said cabinet and said drum for exciting the water molecules thereby speeding evaporation.

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